DATA SHEET

TDA1596
IF amplifier/demodulator for FM radio receivers

Product specification
File under Integrated Circuits, IC01

April 1991

Philips Semiconductors

PHILIPS

IF amplifier/demodulator for FM radio receivers

TDA1596

GENERAL DESCRIPTION

The TDA1596 provides IF amplification, symmetrical quadrature demodulation and level detection for quality home and car FM radio receivers and is suitable for both mono and stereo reception. It may also be applied to common front-ends, stereo decoders and AM receiver circuits.

Features

- Simulates behaviour of a ratio detector (internal field strength and detuning-dependent voltage for dynamic AF signal muting)
- Mono/stereo blend and field strength indication control voltage
- Three-state mode switch for FM, mute-on / FM, mute-off / FM-off
- Internal compensation of AF signal total harmonic distortion (THD)
- Two open collector stop pulse outputs for microcomputer tuning control (can be one stop pulse output by wired-ANDing)
- Internal reference voltage source
- Built-in hum and ripple rejection circuits

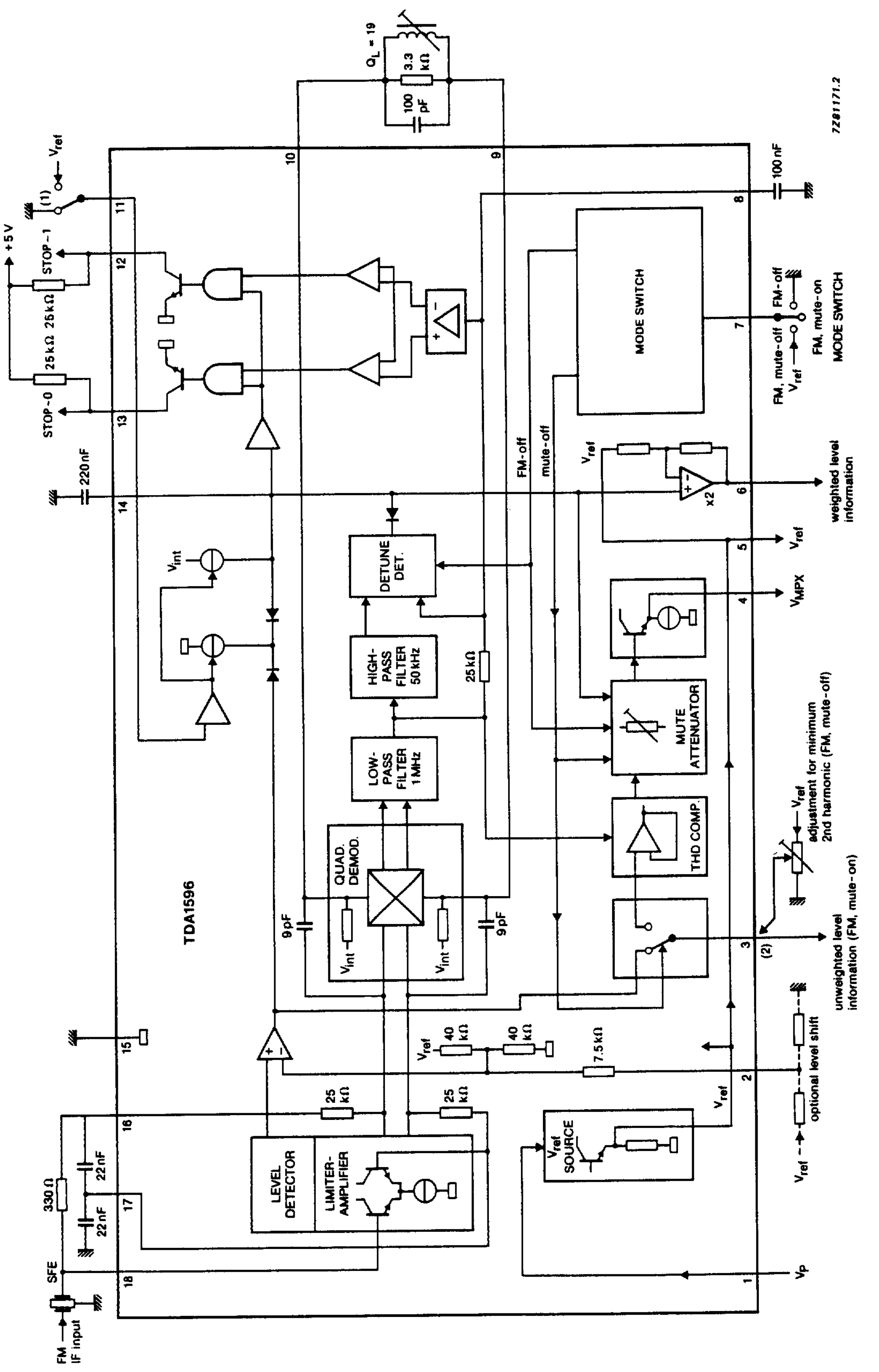
QUICK REFERENCE DATA

PARAMETER	CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply voltage (pin 1)		V_P	7.5	8.5	12.0	V
Supply current (pin 1)	V_P = 8.5 V; $I_2 = I_7$ = 0 mA	I_P	–	20	26	mA
AF output voltage (RMS value)	$V_{18(rms)}$ = 10 mV	$V_{4(rms)}$	180	200	220	mV
Signal-to-noise ratio	$V_{18(rms)}$ = 10 mV; f_m = 400 Hz; Δf = 75 kHz	S/N	–	82	–	dB
Total harmonic distortion	$V_{18(rms)}$ = 10 mV; f_m = 1 kHz; I_7 = 0 mA; Δf = 75 kHz; FM mute on; without de-emphasis; without detuning	THD	–	0.1	0.3	%
Operating ambient temperature range		T_{amb}	–40	–	+ 85	°C

SEE ALSO DATA SHEET FOR TDA1596T

PACKAGE OUTLINE

18-lead DIL; plastic (SOT102); SOT102-1; 1996 August 06.



(1) Connecting pin 11 to ground is only allowed for measuring the current at pin 14. It is not for use in application.

(2) In the FM, mute-on condition the unweighted level detector output is available from pin 3. In the FM, mute-off condition the variable resistor at pin 3 can be adjusted for minimum 2nd harmonic distortion at pin 4.

Fig.1 Block diagram and application circuit.

PINNING

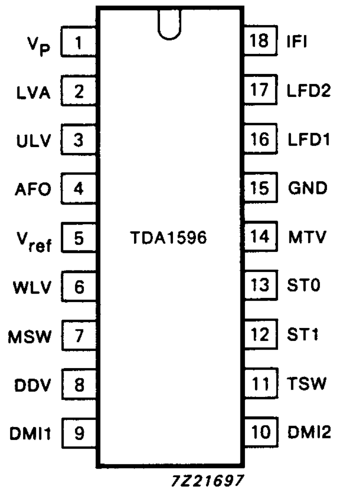


Fig.2 Pinning diagram.

1	V_P	supply voltage
2	LVA	level voltage adjustment
3	ULV	unweighted level output/K2 adjustment
4	AFO	AF output
5	V_{ref}	reference voltage output
6	WLV	weighted level voltage output
7	MSW	mode switch
8	DDV	detune detector voltage
9	DMI1	demodulator input 1
10	DMI2	demodulator input 2
11	TSW	tau switch
12	ST1	stop pulse output 1
13	ST0	stop pulse output 0
14	MTV	mute voltage
15	GND	ground
16	LFD1	IF limiter feedback 1
17	LFD2	IF limiter feedback 2
18	IFI	IF input

FUNCTIONAL DESCRIPTION

Limiter-amplifier

This has five stages of IF amplification using balanced differential limiter-amplifiers with emitter-follower coupling. Decoupling of the stages from the voltage supply lines and an internal high-ohmic DC feed-back loop give a very stable IF performance. The amplifier gain is virtually independent from temperature changes.

FM demodulator

The demodulator is fully balanced and comprises two cross-coupled differential amplifiers. Quadrature detection of the FM signal is performed by feeding one differential amplifier directly from the limiter-amplifier output, and the other via an external 90° phase-shifting network. The demodulator has good stability and its zero cross-over shift is small.
The bandwidth of the demodulator output is restricted to approximately 1 MHz by an internal low-pass filter.

THD compensation

This circuit compensates non-linearities introduced by demodulation. For this to operate correctly the demodulator circuit between pins 9 and 10 must have a loaded Q-factor of 19. Consequently there is no need for the demodulator tuned circuit to be adjusted for minimum THD, instead the adjustment criterium is for a symmetrical stop pulse.

Mute attenuator and AF output

The control voltage for the mute attenuator at pin 14 is generated from the values of the level detector and the detuning detector outputs. The mute attenuator has a fast attack and a slow decay which is determined by the capacitor at pin 14. The AF signal is passed via the mute attenuator to the output at pin 4.

A weighted control voltage, available from pin 6, is obtained from the mute attenuator control voltage via a buffer-amplifier which introduces an additional voltage shift and gain.

Level detector

The level detector generates a voltage output which is proportional to the field strength of the input signal.
The unweighted level detector output is available when the mode switch is operating in the FM, mute-on condition.

Tuning-stop outputs

The open collector outputs STOP-0 and STOP-1 (from pins 13 and 12 respectively) are voltages derived from the detuning level and the field strength of the input signal. If only one tuning-stop output is required, pins 12 and 13 may be tied together.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

PARAMETER	SYMBOL	MIN.	MAX.	UNIT
Supply voltage (pin 1)	$V_P = V_{1-15}$	–0.3	+ 16	V
Reference voltage range (pin 5)	V_{5-15}	–0.3	+ 10	V
Level adjustment range (pin 2)	V_{2-15}	–0.3	+ 10	V
Mode switch voltage range (pin 7)	V_{7-15}	–0.3	+ 16	V
Control input voltage range (pin 11)	V_{11-15}	–0.3	+ 6	V
THD compensation/unweighted field				
strength voltage range (pin 3)	V_{3-15}	–0.3	+ 16	V
Tuning-stop output voltage range				
STOP-0 (pin 13)	V_{13-15}	–0.3	+ 16	V
STOP-1 (pin 12)	V_{12-15}	–0.3	+ 16	V
Tuning-stop output current				
STOP-0 (pin 13)	I_{13}	–	2	mA
STOP-1 (pin 12)	I_{12}	–	2	mA
Storage temperature range	T_{stg}	–55	+ 150	°C
Operating ambient temperature range	T_{amb}	–40	+ 85	°C
Electrostatic handling*				
all pins except pins 5 and 6	V_{es}	–2000	+ 2000	V
pin 5	V_{es}	–2000	+ 900	V
pin 6	V_{es}	–2000	+ 1600	V

* Equivalent to discharging a 100 pF capacitor through a 1.5 kΩ series resistor.

CHARACTERISTICS

f = 10.7 MHz; $V_P = V_{1\text{-}15}$ = 8.5 V; $V_I = V_{18(rms)}$ = 1 mV; T_{amb} = 25 °C; measured in the circuit of Fig.3; tuned circuit at pins 9, 10 aligned for symmetrical stop pulses; all voltages are referred to ground (pin 15); unless otherwise specified

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supplies					
Supply voltage	$V_P = V_1$	7.5	8.5	12.0	V
Supply current at $I_2 = I_7$ = 0 mA	I_1	–	20	26	mA
FM demodulator					
Input impedance	$R_{9\text{-}10}$	25	40	55	kΩ
	$C_{9\text{-}10}$	–	6	–	pF
DC output voltage (no-signal condition) at $V_{9,\,10(p\text{-}p)} \leq 100\ \mu V$; $V_{18(rms)} \leq 5\ \mu V$	V_4	2.75	3.10	3.45	V
Output impedance	$R_{4\text{-}15}$	–	400	–	Ω
Mute attenuator control voltage					
Control voltage (pin 14)					
at $V_{18(rms)} \leq 5\ \mu V$	V_{14}	–	2.0	–	V
at $V_{18(rms)}$ = 1 mV	V_{14}	–	3.45	–	V
Output impedance (pin 14)	$R_{14\text{-}15}$	–	–	2.0	MΩ
Level shift input (pin 2)					
internal bias voltage at I_2 = 0 mA	V_2	–	1.4	–	V
input impedance	$R_{2\text{-}15}$	15	–	–	kΩ
Internal muting (Fig.4)					
Internal attenuation of signals ± 22.5 kHz ≤ detuning ≤ ± 80 kHz $A = 20\log[\Delta V_4(\text{FM mute-off})/\Delta V_4(\text{FM})]$					
at $V_{14} \geq 1\ V_5$	A	–	0	–	dB
at $V_{14} = 0.77\ V_5$	A	1.5	3.0	4.5	dB
at $V_{14} = 0.55\ V_5$	A	–	20	–	dB
Attack and decay (pin 14)					
Pin 11 connected to ground *					
charge current	$+I_{14}$	–	8	–	μA
discharge current	$-I_{14}$	–	120	–	μA
Pin 11 connected to V_{ref}					
charge current	$+I_{14}$	–	100	–	μA
discharge current	$-I_{14}$	–	120	–	μA

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Level detector					
Dependence of output voltage on temperature	$\frac{\Delta V_6}{V_6 \Delta T}$	–	3.3	–	mV/VK
Output impedance	R_6	–	–	500	Ω
Dependence of output voltage (pin 6)					
on input voltage (pin 18) (Fig.5):					
$V_{18(rms)} \leq 5$ µV; $I_2 = I_7 = 0$ mA	V_6	0.1	0.7	1.3	V
$V_{18(rms)} = 1$ mV; $I_2 = I_7 = 0$ mA	V_6	3.0	3.6	4.2	V
Slope of output voltage (pin 6)					
for input voltage range					
$V_{18(rms)} \geq 50$ µV to $V_{18(rms)} \leq 50$ mV	$\frac{\Delta V_6}{20 \Delta \log V_{18}}$	1.4	1.7	2.0	V/20 dB
Dependence of output voltage (pin 6)					
on detuning (Fig.6) at input					
voltage $V_{18(rms)} = 10$ mV:					
detuning ≤ ± 45 kHz	ΔV_6	–	–	0.2	V
detuning = for $V_6 = 1.8$ V	±Δf	90	–	160	kHz
detuning = ± 200 kHz	V_6	0.5	0.7	0.9	V
Slope of output voltage with					
detuning = 125 ± 20 kHz at					
$V_{18(rms)} = 10$ mV	$\lvert\Delta V_6/\Delta f\rvert$	–	35	–	mV/kHz
Level shift control (pin 2) (Fig.7)					
adjustment range	$\pm \Delta V_6$	1.6	2.0	–	V
adjustment gain	$-(\Delta V_6/\Delta V_2)$	–	1.7	–	V
output voltage at $V_2 = V_5$;					
$V_{18(rms)} \leq 5$ µV	V_6	–	–	0.3	V
Low-pass filter at pin 8					
Output voltage at $I_7 = 0$ mA;					
$V_{18(rms)} \leq 5$ µV	V_8	–	2.2	–	V
Internal resistance	$R_{8(int)}$	12	25	50	kΩ

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Tuning-stop detector (Figs 8 and 9)					
Stop-0: detuning at $V_{18(rms)}$ = 10 mV					
for $V_{13} \geq 3.5$ V	+ Δf	–	–	10	kHz
for $V_{13} \leq 0.3$ V	+ Δf	18	–	–	kHz
Stop-1: detuning at $V_{18(rms)}$ = 10 mV					
for $V_{12} \geq 3.5$ V	–Δf	–	–	10	kHz
for $V_{12} \leq 0.3$ V	–Δf	18	–	–	kHz
Dependence of STOP-0, STOP-1 on input voltage (pin 18)					
input voltage (RMS value) for $V_{12} = V_{13} \geq 3.5$ V	$V_{18(rms)}$	250	–	–	μV
input voltage (RMS value) for $V_{12} = V_{13} \leq 0.3$ V	$V_{18(rms)}$	–	–	50	μV
Output voltage when $I_{12} = I_{13}$ = 1 mA	$V_{12, 13}$	–	–	0.3	V
Mode switch and pin 3 (Fig.10)					
FM-off position					
Control voltage for 60 dB muting depth	V_7	–	–	1.4	V
FM, mute-on position (pin 3 = output)					
Internal bias voltage at $R_{7\text{-}15} \geq 10$ MΩ	V_7	–	2.8	–	V
Input current	$\lvert I_7 \rvert$	–	–	2.5	μA
Output voltage with $R_{3\text{-}15}$ = 10 kΩ; $C_{3\text{-}15} \geq 1$ nF**	V_3	–	2	–	V
Output impedance for $V_{18} = \leq 5$ μV; I_3 = 500 μA	$R_{3\text{-}15}$	–	–	100	Ω
FM, mute-off position (pin 3 = input)					
Control voltage	V_7	0.9 V_5	–	–	V
Input current at $V_7 = V_5$	I_7	–	–	15	μA
Input resistance	$R_{3\text{-}15}$	1	–	–	MΩ
Reference voltage source					
Output voltage at I_5 = –1 mA	V_5	3.3	3.7	4.1	V
Output impedance at I_5 = –1 mA	$\Delta V_5/\Delta I_5$	–	40	80	Ω
Temperature coefficient	TC	–	3.3	–	mV/K

* Connecting pin 11 to ground is only allowed for measuring the current at pin 14. It is not for use in application.

** Without input voltage.

OPERATING CHARACTERISTICS

f = 10.7 MHz; $V_{18(rms)}$ = 1 mV; deviation (Δf) = 22.5 kHz; modulation frequency (f_m) = 400 Hz; de-emphasis (pin 4) = 50 µs; test circuit as per Fig.3; tuned circuit (Q_L = 19) aligned for symmetrical stop pulses; T_{amb} = +25 °C; unless otherwise specified

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
AF output voltage (RMS value) at $V_{18(rms)}$ = 10 mV	$V_{4(rms)}$	180	200	220	mV
Start of limiting (FM, mute-off); (RMS value) (Fig.11)	$V_{18(rms)}$	14	22	35	µV
Dependence of signal-to-noise ratio (in noise frequency band 250 Hz to 15 kHz, unweighted) on input voltage					
for S/N = 26 dB	$V_{18(rms)}$	–	15	–	µV
for S/N = 46 dB	$V_{18(rms)}$	–	60	–	µV
at $V_{18(rms)}$ = 10 mV; Δf = 75 kHz	S/N	–	82	–	dB
THD (FM, mute-on) at $V_{18(rms)}$ = 10 mV; Δf = 75 kHz; f_m = 1 kHz; without detuning; without de-emphasis; I_7 = 0 mA	THD	–	0.1	0.3	%
Dynamic mute attenuation (Fig.12) $\alpha_D = 20\log\frac{V_4(FM mute-off)}{V_4(FM, mute-on)}$ with f_m = 100 kHz; Δf = 75 kHz	α_D	–	16	–	dB
Slope of attenuation curve	$\alpha_D\Delta f$	–	0.8	–	dB/kHz
THD (FM, mute-on) at $V_{18(rms)}$ = 10 mV; Δf = 75 kHz; f_m = 1 kHz; detuning ≤ ± 25 kHz without de-emphasis; I_7 = 0 mA (Fig.13)	THD	–	–	0.6	%
THD (FM, mute-off and compensated via pin 3) at $V_{18(rms)}$ = 10 mV; Δf = 75 kHz; f_m = 1 kHz; $V_7 = V_5$	THD	–	0.07	0.25	%
Voltage range at pin 3 for THD compensation	V_3	0	–	V_5	V
AM suppression (FM, mute-off) with amplitude modulation at 30%; input voltage range V_{18} = 300 µV to 100 mV (Fig.14)		–	65	–	dB
Power supply ripple rejection = 20log [$\Delta V_1/\Delta V_4$]		33	36	–	dB
Mute attenuation (FM-off) = 20log [$V_{4(FM-on}/V_{4(FM-off)}$]		60	–	–	dB

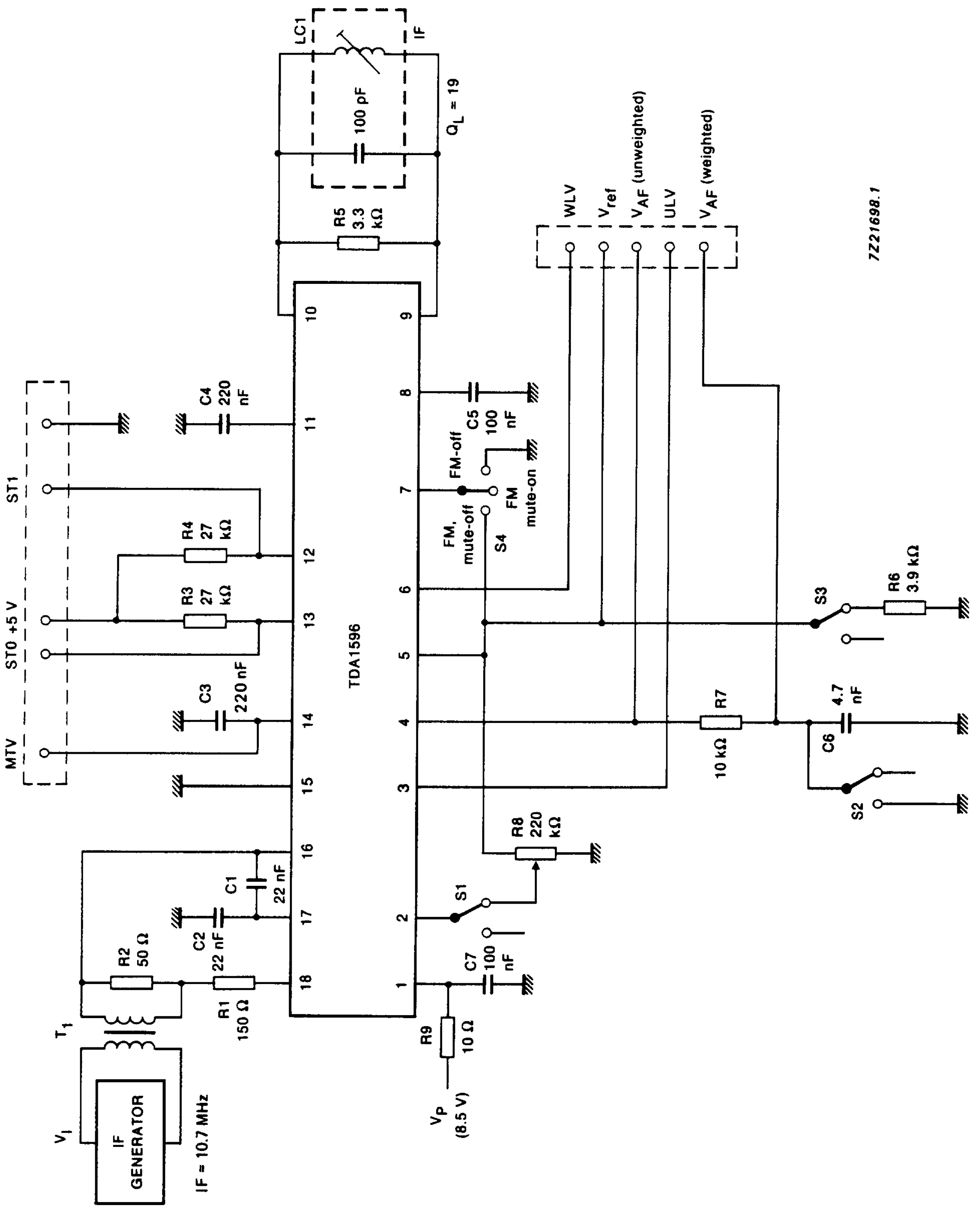


Fig.3 Test circuit.

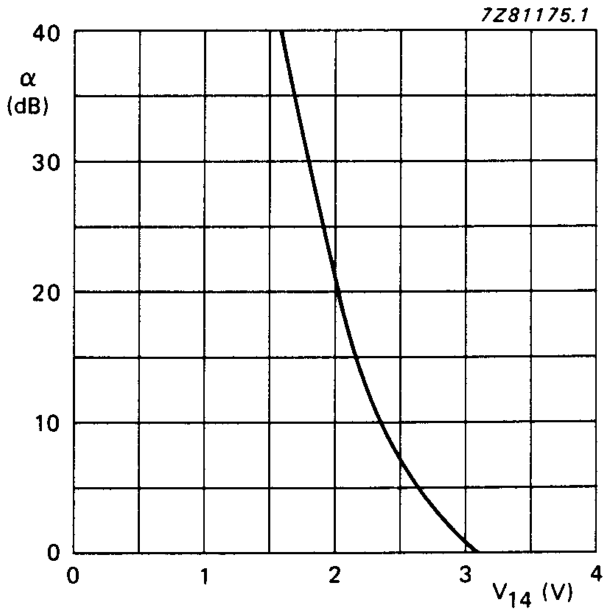


Fig.4 Typical curve of internal attenuation showing the relationship between the mute attenuator control voltage (pin 14) and mute attenuation, $I_2 = I_7 = 0$ mA.

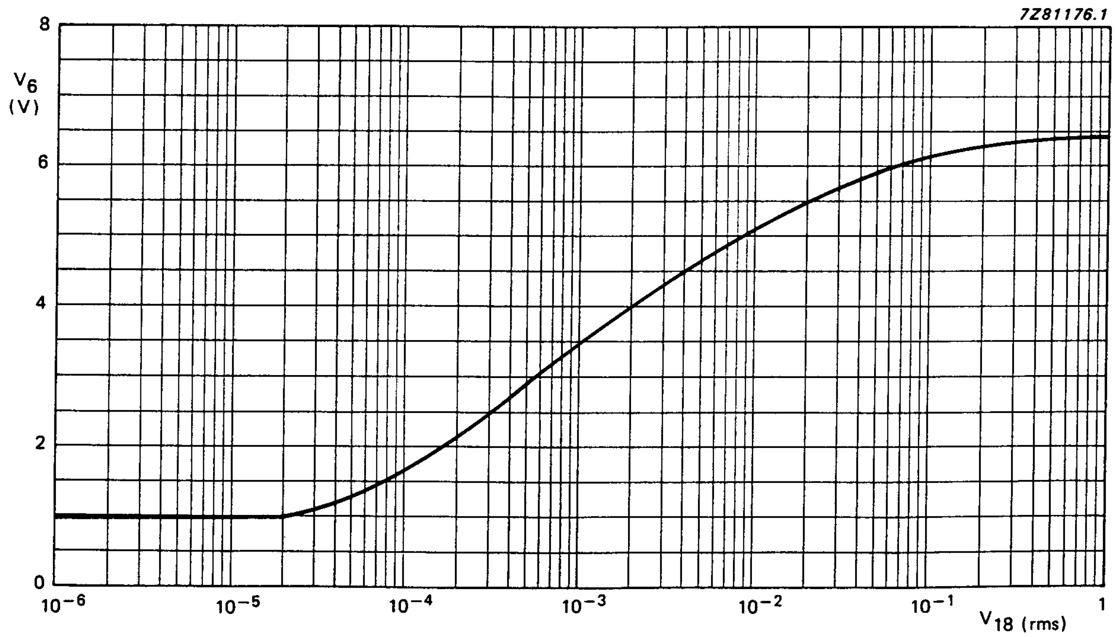


Fig.5 Weighted field strength output voltage (pin 6) as a function of input voltage (pin 18); $R_{6\text{-}15} \geq 10$ kΩ; $I_2 = I_7 = 0$ mA.

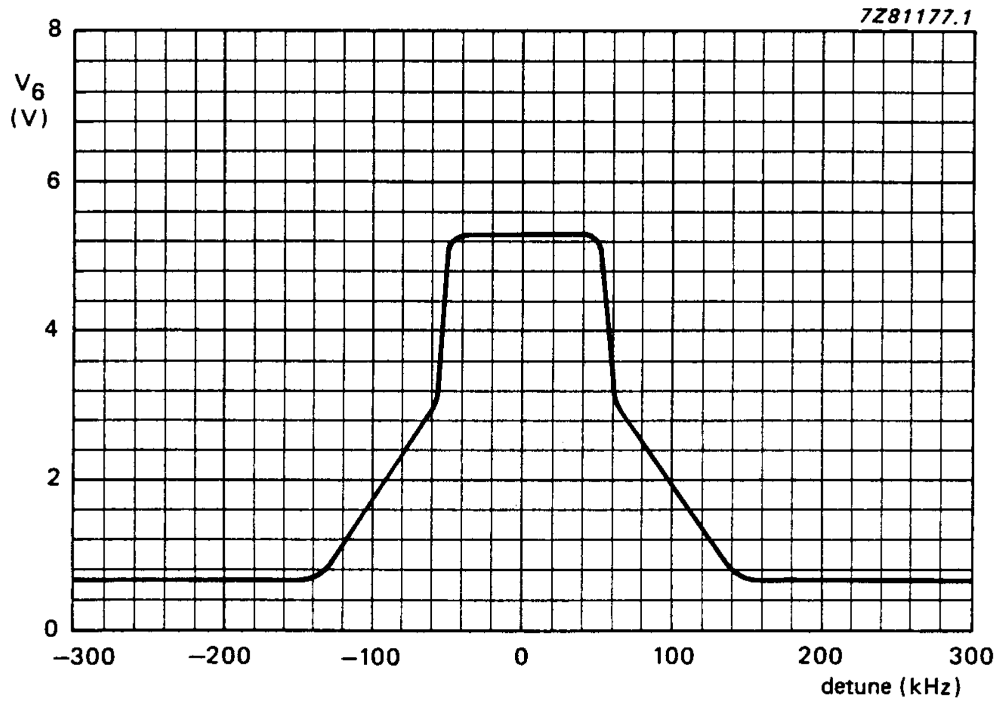


Fig.6 Weighted field strength output voltage (pin 6) as a function of detuning; $R_{6\text{-}15} \geq 10\ k\Omega$; $I_2 = I_7 = 0\ mA$; $V_{18} = 10\ mV$.

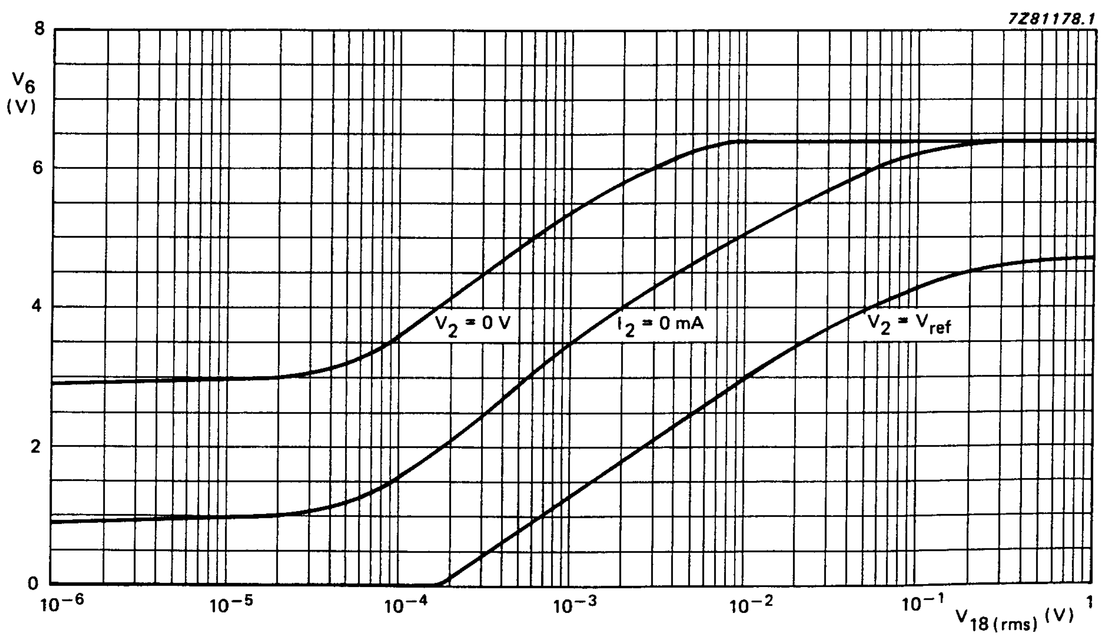
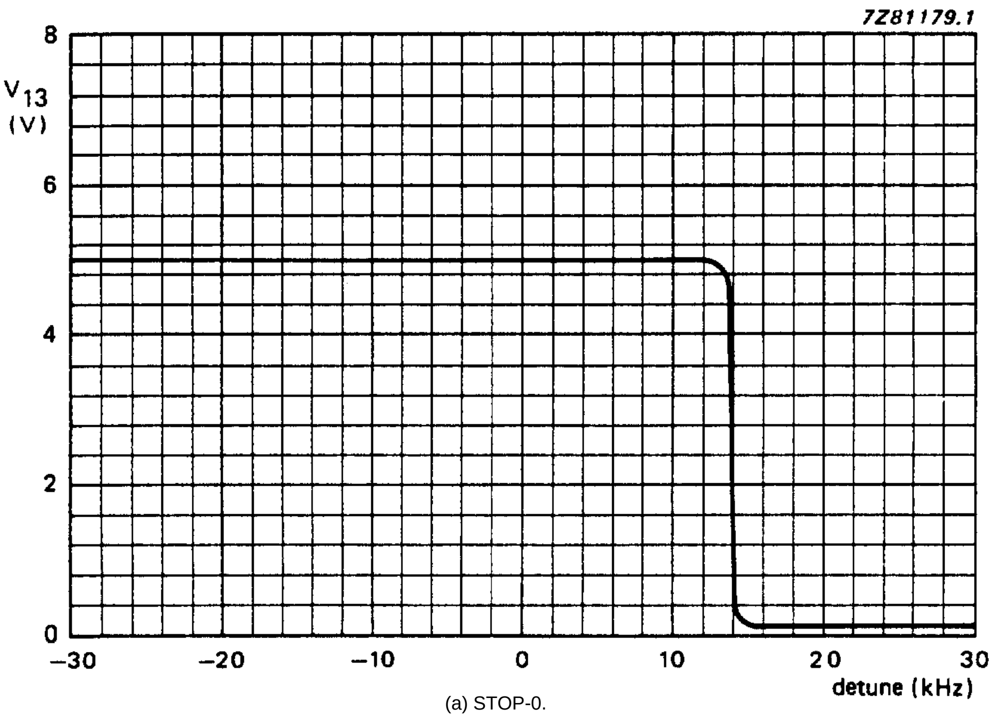
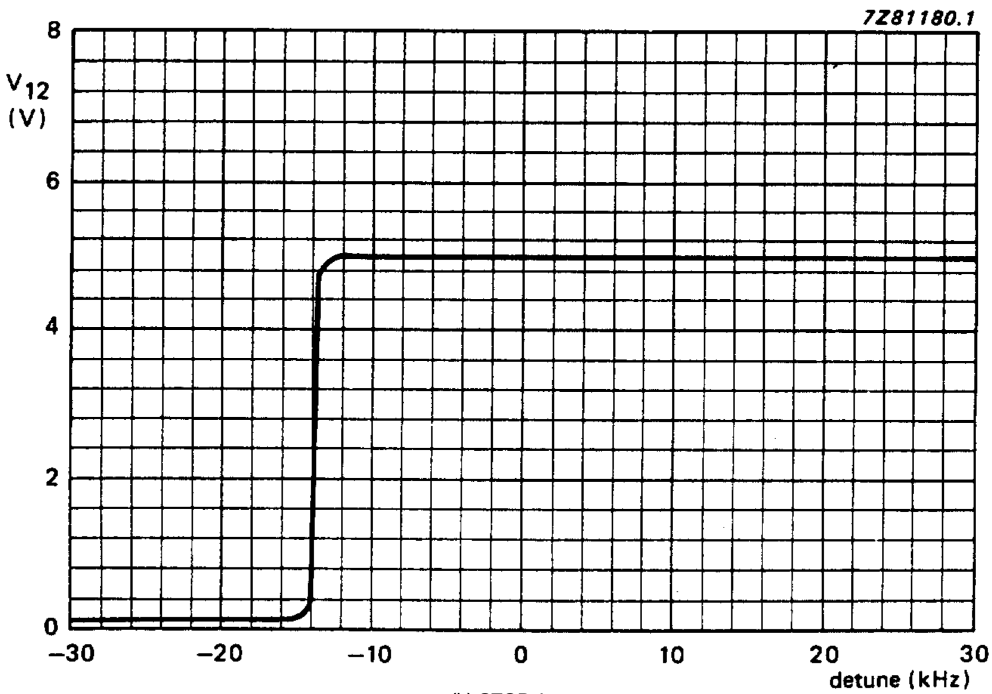


Fig.7 Adjustment range of weighted field strength output voltage (pin 6) with level shift control (pin 2); $R_{6\text{-}15} \geq 10\ k\Omega$; $I_7 = 0\ mA$.



(a) STOP-0.



(b) STOP-1

Fig.8 STOP-0 and STOP-1 output voltages as a function of detuning, measured at V_{18} = 10 mV.

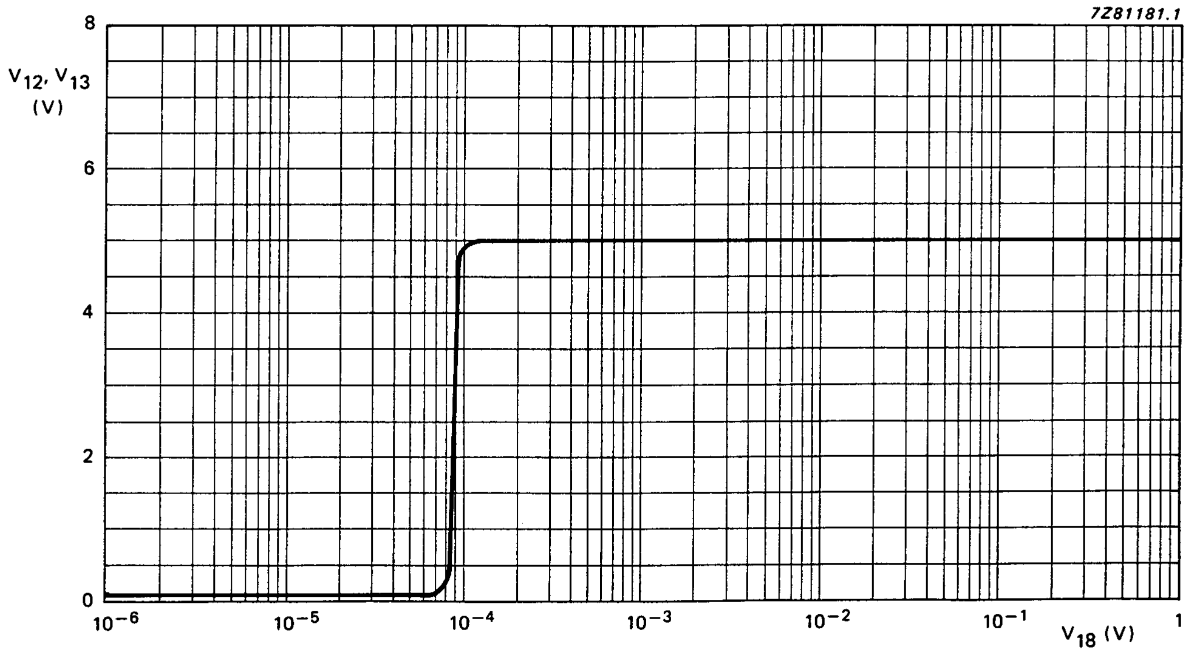


Fig.9 STOP-0 or STOP-1 output voltages as a function of input voltage at pin 18.

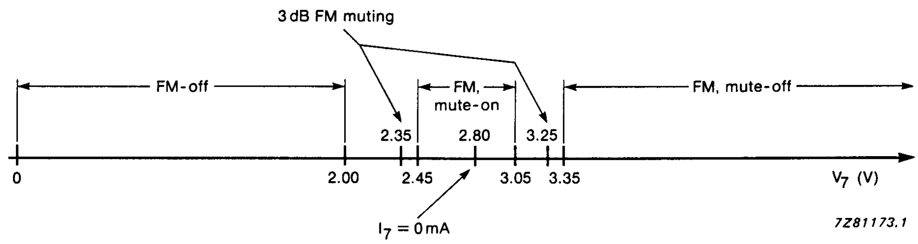
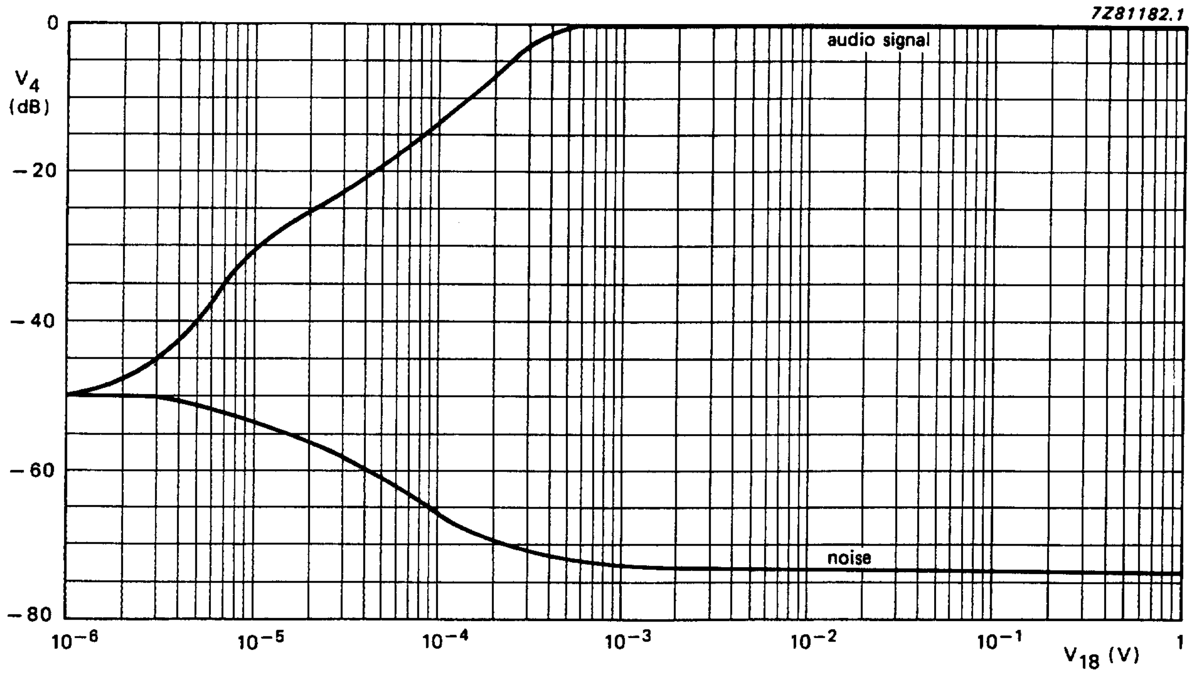
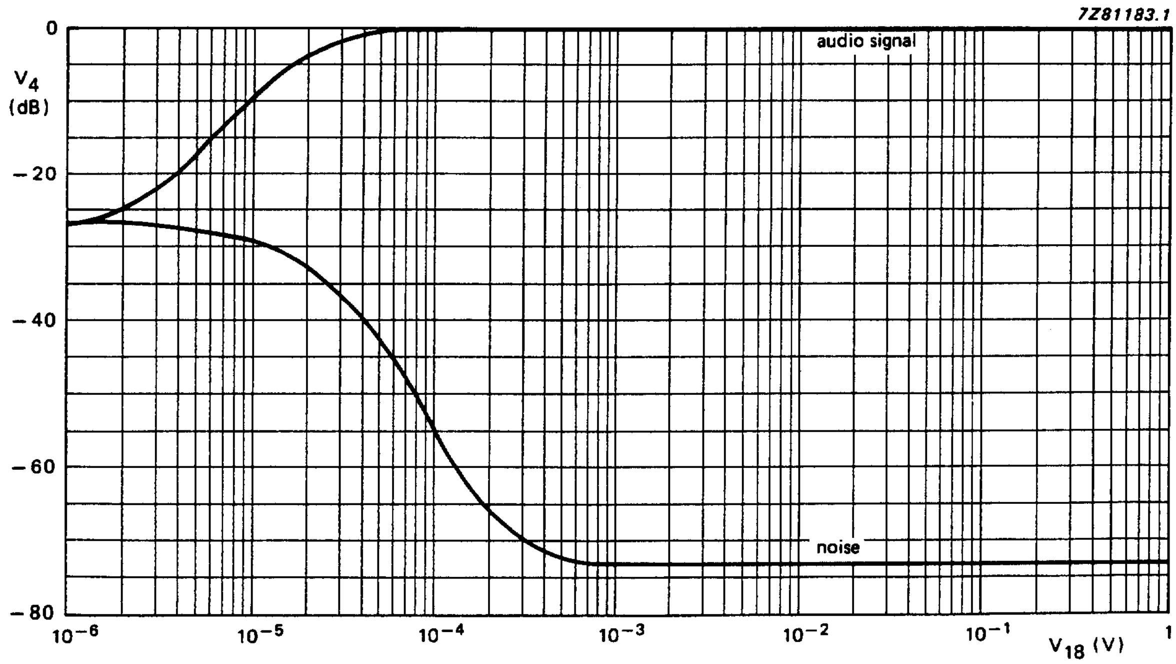


Fig.10 Switch levels at pin 7.



(a) mode switch at FM, mute-on



(b) mode switch at FM, mute-off

Fig.11 Audio signal (Δf = 22.5 kHz; f_m = 1 kHz) and noise as functions of input voltage at pin 18; measured with 50 µs de-emphasis.

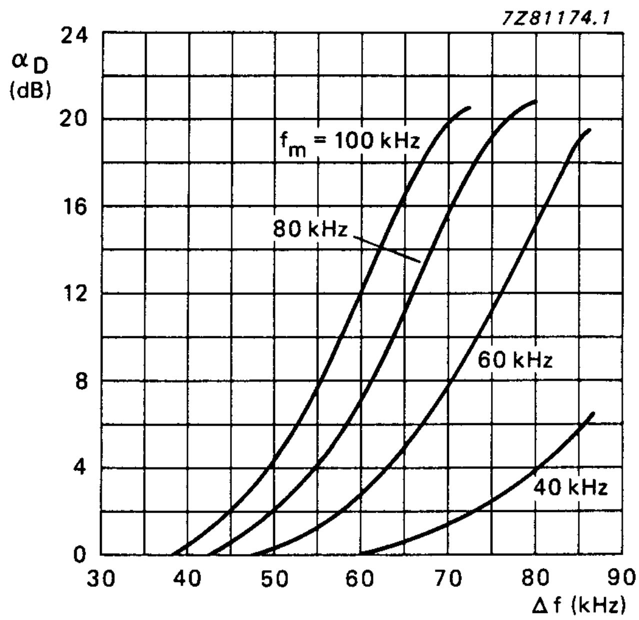


Fig.12 Dynamic mute attenuation as a function of frequency deviation for modulation frequencies of 40, 60, 80 and 100 kHz.

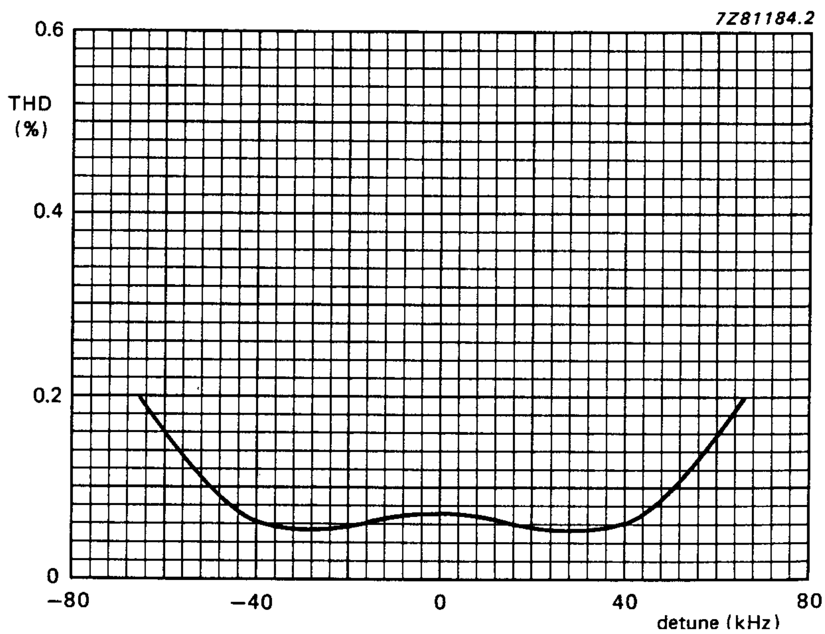
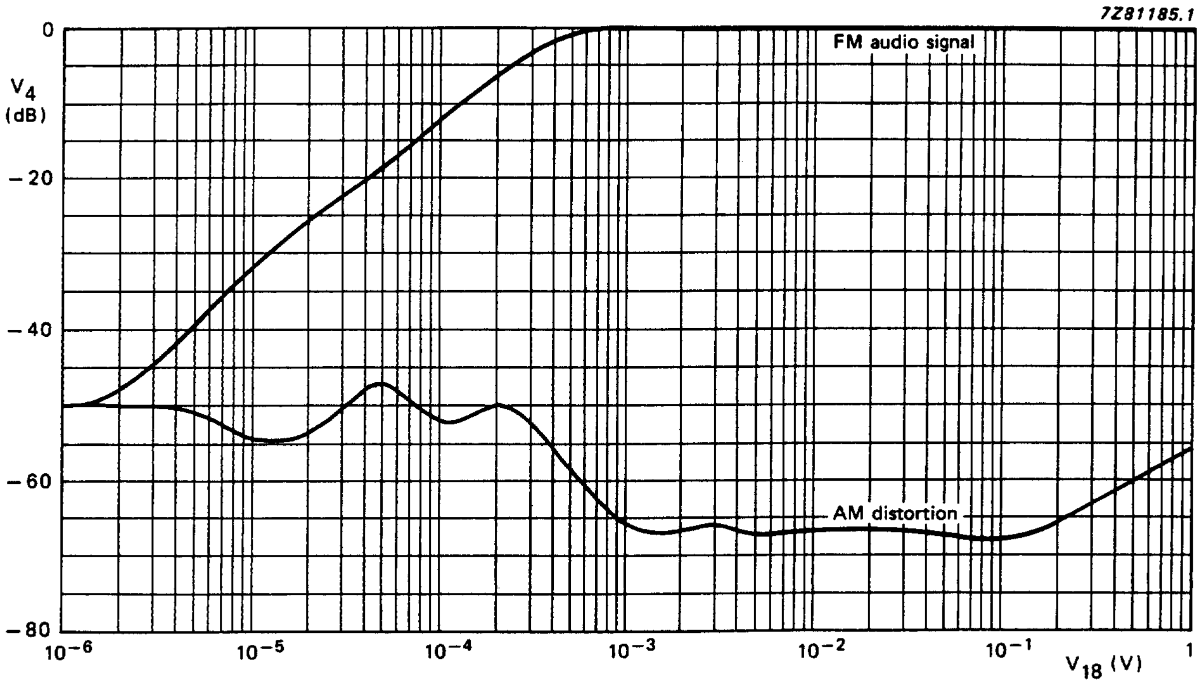
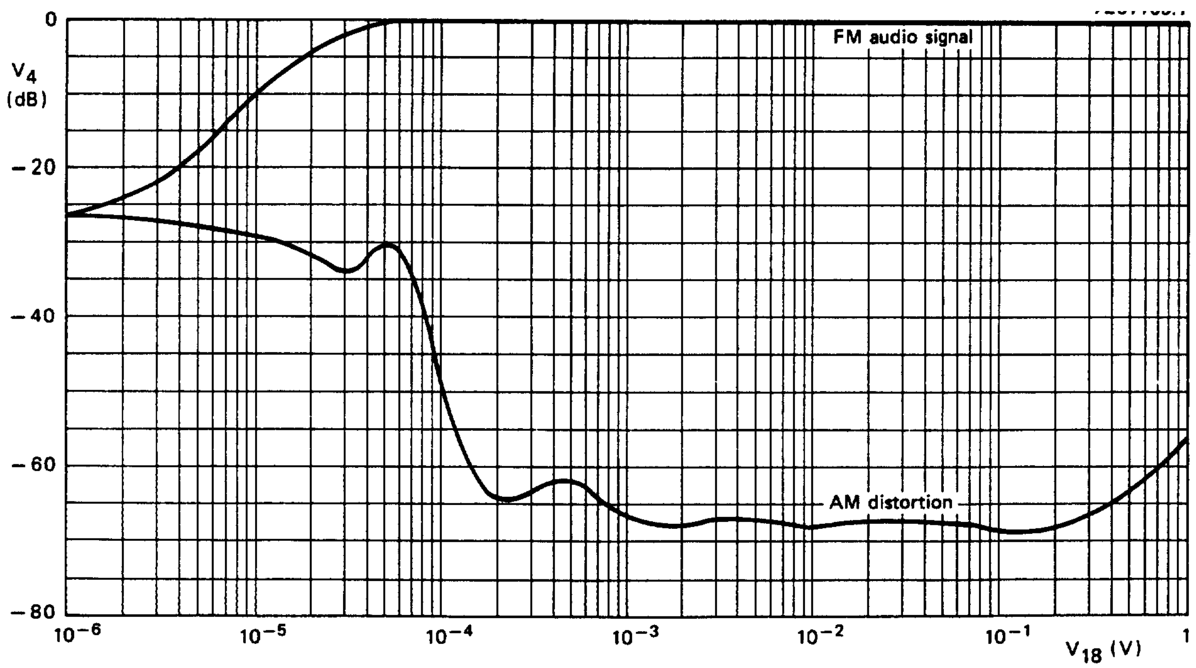


Fig.13 THD as a function of detuning; mode switch at FM, mute-on position; Δf = 75 kHz; f_m = 1 kHz; $V_{18(rms)}$ = 10 mV.



(a) mode switch at FM, mute-on.

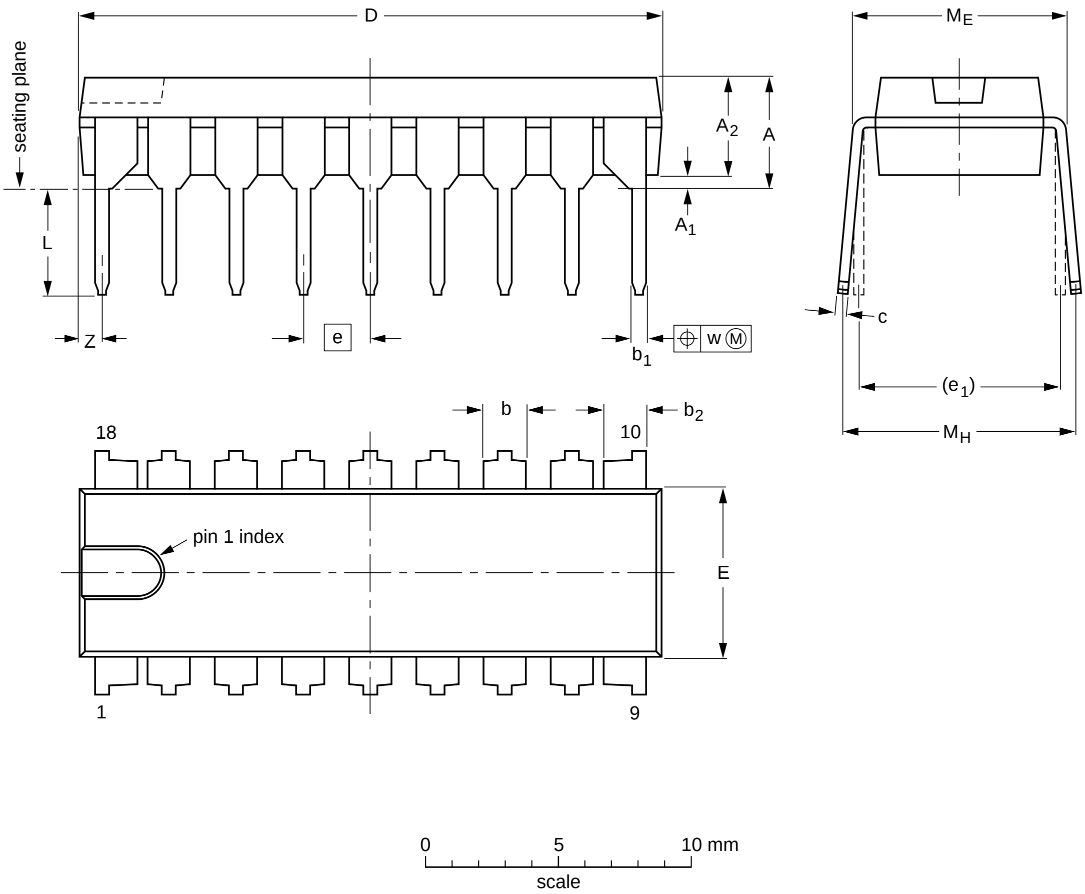


(b) mode switch at FM, mute-off

Fig.14 Typical curves showing AM suppression for an input signal having frequency modulation at Δf = 22.5 kHz and f_m = 1 kHz, and amplitude modulation of 30% at a frequency of 400 Hz; de-emphasis time = 50 µs and bandwidth = 250 Hz to 15 kHz.

PACKAGE OUTLINE

DIP18: plastic dual in-line package; 18 leads (300 mil) **SOT102-1**



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A_1 min.	A_2 max.	b	b_1	b_2	c	D (1)	E (1)	e	e_1	L	M_E	M_H	w	Z (1) max.
mm	4.7	0.51	3.7	1.40 1.14	0.53 0.38	1.40 1.14	0.32 0.23	21.8 21.4	6.48 6.20	2.54	7.62	3.9 3.4	8.25 7.80	9.5 8.3	0.254	0.85
inches	0.19	0.020	0.15	0.055 0.044	0.021 0.015	0.055 0.044	0.013 0.009	0.86 0.84	0.26 0.24	0.10	0.30	0.15 0.13	0.32 0.31	0.37 0.33	0.01	0.033

Note

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT102-1						~~93-10-14~~ 95-01-23

SOLDERING

Introduction

There is no soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and surface mounted components are mixed on one printed-circuit board. However, wave soldering is not always suitable for surface mounted ICs, or for printed-circuits with high population densities. In these situations reflow soldering is often used.

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our *"IC Package Databook"* (order code 9398 652 90011).

Soldering by dipping or by wave

The maximum permissible temperature of the solder is 260 °C; solder at this temperature must not be in contact with the joint for more than 5 seconds. The total contact time of successive solder waves must not exceed 5 seconds.

The device may be mounted up to the seating plane, but the temperature of the plastic body must not exceed the specified maximum storage temperature ($T_{stg\ max}$). If the printed-circuit board has been pre-heated, forced cooling may be necessary immediately after soldering to keep the temperature within the permissible limit.

Repairing soldered joints

Apply a low voltage soldering iron (less than 24 V) to the lead(s) of the package, below the seating plane or not more than 2 mm above it. If the temperature of the soldering iron bit is less than 300 °C it may remain in contact for up to 10 seconds. If the bit temperature is between 300 and 400 °C, contact may be up to 5 seconds.

DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.